On the forms of Rattus rattus occurring on the mainland of the Malay Peninsula[1]

By F. N. CHASEN

The Malay Peninsula is here regarded as extending from the Isthmus of Kra at Lat. 10° N. south to Singapore.

The large collection of *Rattus rattus* in the Raffles Museum has been reviewed: the chief result is the proof of the existence of a hitherto unrecognized third form of the species in the Peninsula.

For some time it has been recognized that in the island of Java and elsewhere[2] three distinct, stable forms of *R. rattus* are found. In Java these are the indigenous, white-bellied field rat, *R. r. roquei* Sody[3]; a coarser dark-bellied form, *R. r. diardi* (Jentink) found in houses and the neighbourhood of villages and usually regarded as a derivative of the first named form, now semi-parasitic on man; and thirdly, a rice-field rat, *R. r. brevicaudatus* Horst and de Raadt, not unlike *roquei* in general appearance but with a shorter tail[4].

Such an association of forms has not yet been proved to exist in the Malay Peninsula but it could be expected to occur, for it can be noted that in 1918 Robinson and Kloss gave to an unique skin and skull of a rat from Korinchi, west Sumatra the name *R. r. argentiventer*[5], and that ten years later Chasen and Kloss referred to this new form but without direct comparison with the type another single specimen from east Borneo[6].

Furthermore, in the Raffles Museum a few Malayan specimens of *R. rattus* have been for several years segregated as probably distinct from *jalorensis* and *diardi* but the material was too poor to repay detailed study.

Now, however, I have received through the Entomologist of the Institute for Medical Research in Kuala Lumpur and the Agricultural Field Officer, Krian, Perak, good series of the doubtful form from Perak and there can be no doubt that it is distinct from both *jalorensis* and *diardi* although, until a reasonable series of *argentiventer* is available from Sumatra, it is inadvisable to separate the Perak animals from that form.

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[1] The forms inhabiting the islands in the Straits of Malacca were reviewed by Mr. C. Boden Kloss and myself in Bull. Raffles Mus., 5, 1931, p. 76.

[2] *See* Dammerman, Treubia, X, 1928, p. 307.

[3] *R. r. roquei* is very close to *jalorensis* but it averages slightly larger.

[4] The distribution of the races of *R. rattus* in Java is discussed by F. Kopstein in detail in "Die Okologie der javanischen Ratten" (Zeitschrift fur Morphologie und Okologie der Tiere", 22, 4, 1931, p. 774.

[5] Journ. F.M.S. Mus., viii, pt. 2, 1918, p. 55.

[6] Journ. Malay. Br. Roy. Asiat. Soc., vi, 1928, p. 47.

I have to thank the Directors of the Zoological Museums at Buitenzorg, Java and at Colombo, Ceylon who kindly sent me material to study during the preparation of this paper.

1. **Rattus rattus jalorensis.** The Field-rat.

Mus jalorensis Bonhote, Fasciculi Malayenses, Zool., pt. i, 1903, p. 28 ("Ban Sai Kau, Nawngchik," Peninsular Siam).

External characters. A sleek rat. The under parts, in the great majority of specimens, white, sharply defined on the sides against the finely grizzled upper parts, but the base of the fur on the under parts sometimes grey and the general appearance below therefore cloudy.

Tail entirely black; half-way along its length the rings 9 to 11 to the centimetre.

Tail usually slightly longer than the head and body: occasionally it is a trifle shorter.

Size. No exact topotypes from Nong Chik (between Jalor and the sea, about Lat. 6° 50′ N.) are available. Some adults from Ghirbi about 100 miles north of the latitude of Nong Chik average rather longer in the tail than the largest specimens from the Malay States. As the measurements of the latter agree better with the figures given by Bonhote for typical *jalorensis* the Ghirbi specimens may be regarded as showing an approach to a slightly larger northern form. In the Malay States, are found rats in which the skull attains a maximum of 17.5% above the minimum occipito-nasal length for adults. This large variation is puzzling but although I have gone to some trouble to seek confirmation of Bonhote's view that two forms of field-rat occur I cannot support his contention that a smaller form, *jalorensis* differs from a larger form *"rufescens"* in its darker, more uniform upper surface, black feet, and shorter tail and ear.

The great majority of specimens examined from the Peninsula consists of young rats. The minority, with worn teeth, can be arranged in three series according to the greatest length of the skull, series *a* less than 40 mm., *b* 40–42 mm., *c* 42–44.4 mm. Most of the local rats with worn teeth fall in series *a* and each series includes skulls in which the teeth are *very* worn.

It is not easy to arrange large series of skulls, comparatively, with regard to age although of course very old animals can usually be picked out[1], but there is no doubt that most of the skulls in *a* are younger than those in *b* and *c*. A few, at first sight adult, are rather too broad in the cranium: others, seen from above, have the sutures of the cranial vault too obvious, and in others the "beading" is not heavy enough to indicate old age. Eliminating skulls on all these counts only five remain in series *a* and it is doubtful whether even these few are the skulls of very old animals: nevertheless, they must be included in any series of measurements of adults. As, however, it was not found necessary to eliminate any skull from the series *b* and *c* (*i.e.* skulls of 40 mm. or more in occipito-nasal length) on grounds of immaturity it is reasonable to regard the five small skulls as either exceptionally small adults or, in spite of their appearance, perhaps not fully grown: I incline to the latter view.

In the following table the individual measurements[1] of *jalorensis* given on pages 12 and 13 are summarized. The first two columns contain the sixteen largest adults available from the Malay States and the third column the five smallest adults from the same area. The fourth column contains the measurements of four animals from Ghirbi in Peninsular Siam. The skulls of these last mentioned specimens are all large although the teeth are not very worn. This point is referred to at greater length below.

Dimension	Largest adults between Lat. 7° and 4° N.	Largest adults south of Lat. 4° N.	Smallest adults south of Lat. 7° N.	Adults from Ghirbi, about Lat. 8° N.
External.—				
Head and body ..	166-175 (170)	154-176 (166)	155-165 (158.5)	158-170 (164)
Tail ..	160-193 (177)	155-185 (173.9)	161-173 (165)	176-200 (192.5)
Hind-foot ..	32-35 (33)	27-33 (30.7)	29-33 (30.8)	32-35 (34)
Ear ..	20-22 (21)	17.5-22 (19.9)	16-20 (17.7)	17-22 (20.2)
Percentage of tail to head and body ..	95-115 (104)	88-112 (105)	101-106 (104)	111-122 (117)
Skull—				
Occipito-nasal length	40.5-44.3 (42.1)	40-42.8 (41.2)	37.7-39.3 (38.6)	40.7-44.4 (42.2)
Condylo-basilar length	35.5-38.4	34.8-37.4	32.6-34.5	35-37.7
Greatest zygomatic breath ..	18.8-20.6	18.3-20.7	17.8-19	19.2-19.8
Post-molar length ..	17.6-18.4	17.1-18.7	15.6-17.1	17.1-18.9
Length of a nasal ..	13.7-16	13.7-15.1	12.7-13.5	14.4-16.1
Palatilar length ..	19.5-21.4	18.7-20.4	17.9-19	19.3-20.5
Diastema ..	10.9-12.3	10.7-12	10-10.8	10.6-11.5
Anterior palatal foramina ..	7.2-7.7	6.7-7.9	6.1-6.9	6.9-7.8
Upper Molar row ..	6.5-7.2	6.3-7.1	5.9-6.7	6.7-7

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[1] None of the characters seems decisive. The teeth are well worn in some skulls showing unmistakable signs of immaturity and this character seems to depend on the local habitat and nature of the food. In one obviously very old skull the sutures anterior to the basioccipital and basisphenoid bones are not closed: the condition of the sutures is sometimes altered by careless cleaning of the skulls.

[1] In all cases the external measurements were taken in the flesh but unfortunately over a period of years and by several different collectors. Hind-foot excludes claws. Upper molar row at the alveoli. Palatilar length excludes any median palatal projection. Post-molar length, condyle to m^3.

The figures in brackets are the averages. The series left for study after the elimination of immature animals are, unfortunately, not very large.

Adults of *Rattus rattus jalorensis* from the Malay Peninsula, from the type locality in the north and south to Johore therefore give the following ranges in millimetres. Some averages are added in brackets.—

Head and body	154–176 (165.6)
Tail	155–198 (173)
Hind-foot	27–35 (31.4)
Ear	16–22 (19.8)
Percentage of tail to head and body	88–115 (104.5)
Occipito-nasal length	37.7–44.3 (40.9)
Condylo-basilar length	32.6–38.4
Greatest zygomatic breadth	17.8–20.7
Post-molar length	15.6–18.7
Length of a nasal	12.7–16
Palatilar length	17.9–21.4
Diastema	10–12.3
Anterior palatal foramina	6.1–7.9
Upper molar row	5.9–7.2

Mammae. The number seems to be constant. All females examined have two pairs of pectoral and three pairs of inguinal mammæ making ten teats in all.

Characters of the skull. A line drawn across the anterior roots of M^1 excludes the palatal foramina in the great majority of skulls and in a small minority of skulls (the proportion largest in immature animals) just includes the extreme posterior tips of the foramina for a length of less than .5 mm. In two skulls about .75 mm. is included.

Range in the Malay Peninsula. From central, east and north Johore and Malacca north to at least lat. 6° 50′ N. It is probably the form inhabiting west and parts of south-west Johore also. Penang Island and Pulau Pangkor Besar in the Dindings.

2. **Rattus rattus jalorensis > tikos** Hinton.

Rattus rattus tikos Hinton, Journ. Bombay Nat. Hist. Soc., xxvi, 1919, p. 400 (Tenasserim Town).

The above is a convenient way of indicating specimens from the Malay Peninsula, north of about latitude 8° N.

In order to appreciate the exact systematic position and status of these northern rats it is necessary to glance at their relation to the field forms of *R. rattus*[1] found in the countries immediately north of the Malay Peninsula.

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[1] The validity of the various names that have been applied to these races is not a question of concern at the moment and they are here accepted as published. *R. r. thai* (1917) was directly compared with the earlier *sladeni* Anderson (1878) from the Kakhyen Hills near Bhamo and described as having larger bullæ: no colour comparison was possible as the types of *sladeni* are preserved in alcohol. *R. r. khyensis* (1919) was described without reference to either of the foregoing names and differences between it and them have yet to be demonstrated.

A convenient starting point is in Upper Burma whence, a few miles west of Kindat on the Chin Hills *R. r. khyensis* Hinton[1] was described. The known range of this form, as given by its describer is, approximately from Kindat, east to a point in the north Shan States between Mandalay and Lashio, and south through Mount Popa to Pegu in Lower Burma.

Next comes *R. r. thai* Kloss[2] described from Raheng, west Siam and as yet only known, as such, from the topotypical district.

Yet further to the south is *R. r. tikos* Hinton.[3] With topotypes from Tenasserim Town the author of the name associated animals from various localities to the extreme southern point of Tenasserim and Victoria Island.

Finally, from Nong Chik, just north of Jalor in the south of Peninsular Siam, came *R. r. jalorensis* Bonhote[4], the presumably, indigenous field-rat of the Malay Peninsula. I have not seen *khyensis* but both *thai* and *jalorensis* seem reasonably stable forms. In the country between that occupied by these last two races in their purest form the species is highly variable and racial recognition is little more than a formality. Below, I have tried to summarize the characters of series of *R. rattus* from various localities from north to south: in some of the extra-Malayan cases I have had to rely absolutely on Mr. Hinton's published figures and descriptions.

Colour. Khyensis is described as a bright rat ("bright coloured, red-backed"). *Thai* must also be called a bright rat. Animals from Tenasserim Town south to Victoria Point are very variable: a few are as bright as some *thai,* others are as dull as any *jalorensis.* As a series *tikos* averages duller than *thai: jalorensis* is consistently dull in colour.

Mammae.—The formula is $3-3=12$, or $2-3=10$: occasionally the pectoral mammæ are asymmetrical and then there are 11 mammæ in all. Typical *khyensis* from the Chin Hills has 12 mammæ but among 14 females of the same form from the North Shan States 1 had 11 and 2 had 10. Females from Mt. Popa, Pagan and Pegu all show 12. Of *tikos* Mr. Hinton writes "The mammæ are visible in 26 of the females; of these 8 only show the full formula of $3-3=12$, 9 show 11, and 9 show $2-3=10$." Animals with three pairs of pectoral mammæ extend south to Bankasoon (and perhaps Victoria Point but details are lacking) on the western side of the peninsula and to Koh Lak in south-west Siam on the other side: others with only two pairs extend north to Maprit, Tenasserim Town, and near Bangkok. There is thus a large overlap. From Ghirbi (perhaps from a point further north) southwards the formula $2-3=10$ seems constant.

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[1] Journ. Bomb. Nat. Hist. Soc., xxvi, 1919, p. 398.

[2] Journ. Nat. Hist. Soc. Siam, ii, 1917, p. 286.

[3] Journ. Bomb. Nat. Hist. Soc., xxvi, 1919, p. 400.

[4] Fasciculi Malayenses pt. 1, 1903, p. 28.

Skull.—The average occipito-nasal length of a series of good adults from most of the northern localities seems slightly higher than that of Malayan *jalorensis* which is 40.9 mm. Working to the north we get the following averages in millimetres for small series. Ghirbi, Peninsular Siam, 42.2; Koh Lak, south-west Siam, 43.5; south Tenasserim, 42.4; west Siam, 42.6; *khyensis* over its defined range drops to 40.6 again but only two of the skulls are said to have the teeth much worn.

Tail.—The following are some ranges and averages in millimetres of tail-length and average percentage of tail-length (last column) to that of the head and body. The figures for localities in Burma are taken from Hinton. In most cases the average length and the average percentage of tail-length seem to be based on a larger number of specimens than that represented by the range of the actual tail-length unless of course this latter includes the extremes of the available series.

Chin Hills ..	175–194	(182)	.. 111
North Shan States	168–222	(186)	.. 111
Mt. Popa ..	195–222	(198)	.. 120
Pagan ..	158–196	(181)	.. 120
Pegu	180–214	(197)	.. 121
West Siam ..	170–210	(195)	.. 108
South Tenasserim ..	161–216	(169)	.. 108
Koh Lak ..	193–235	(214!)	.. 118
Ghirbi	176–200	(192.5)	.. 117
Malay States ..	155–193	(173)	.. 104.5

To sum up, we have a rat occurring over a wide stretch of country, possibly without a serious break in distribution. Generalizing, it can be said that in the north it is bright in colour and has three pairs of pectoral mammæ: in the south it is dull in colour and has two pairs of pectoral mammæ. Furthermore, the largest skulls and longest tails are found north of the range of *jalorensis*. At irregular, and in the case of the earlier names more or less accidentally chosen points on the continuous, although not quite even line of variation, various names have been applied to the species. About these centres it is the practice of modern systematists to group their geographical races or sub-species. Unfortunately the type localities, often fixed, as

Mr. Hugh Whistler has recently pointed out, with regard to birds, on grounds of nothing more or less than historical accident, are sometimes in intermediate areas where the species is unstable and highly variable. For practical purposes the range of *R. r. jalorensis* can for the present be considered as extending to roughly Lat. 7° N. Animals from a degree further north are not quite typical: they average rather large in the skull (it has already been pointed out that the few specimens listed are not aged animals) and long tails are beginning to appear. At Lat. 10° N. the nominal race *R. r. tikos* with three pairs of pectoral mammæ occurs although this character, like the colour, is unstable. *Tikos* is an insignificant link between *jalorensis* in the south and *thai*, the range of which is not yet known in any detail, in the north.

3. **Rattus rattus jalorensis> rhionis** Thos. and Wrought.

Rattus rattus rhionis Thomas and Wroughton, Ann. Mag. Nat. Hist. (8), iii, 1909, p. 441 (Bintang Island, Rhio Archipelago).

It has already been pointed out[1] that rats in south Johore are conspicuously darker on the back than *jalorensis* and thus approach *rhionis* of the eastern islands in the Rhio Archipelago although they do not attain the large average size of that form (occipito-nasal length of ten adults of *rhionis* 43–45 mm.).

The exact distribution of these darker animals has yet to be worked out. In the territory of Malacca, at Segamat in north Johore, and at Leman Point on the east coast of the State *jalorensis* occurs, but the form found at Tanjong Penang on the south bank of the Lebam estuary, at Pasir Gudang and Tanjong Gomok on the north bank of the Johore Strait, and at Pelepak in south Johore is > *rhionis* as are a few skins merely labelled "Kota Tinggi."

Ecology. On the mainland all the rats described above are found in forest land, including mangrove forest, and to a lesser extent in secondary jungle, on both sides of the Peninsula and throughout its length, but they seem to be less common in their natural habitat than are the rats described below in theirs. Essentially lowland animals they have not been collected above 3000′ although examples are known from 2000′ in Perak and from between 2000–3000′ at the Semangko Pass (now better known as "the Gap") on the Selangor-Pahang boundary. It is noteworthy that no field-rat of this species has ever been recorded from Singapore Island.

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[1] Chasen and Kloss, Bull. Raff. Mus., 5, 1931, p. 76.

Rattus rattus jalorensis

Locality	Sex	External Measurements					Skull									Reg. No.
		Head and body	Tail	Hind-foot	Ear	Percentage of tail to head & body	Greatest length (occi-pitonasal)	Condylo-basi-lar length	Greatest zygomatic breadth	Post-molar length	Length of a nasal	Palatilar length	Length of diastema	Anterior palatal foramina	Upper molar row	
Above Lat. 4° N.																
Taiping, Perak ..	♂	175	179	32	20	102	40·5	35·5	18·8	18	13·7	19·5	10·9	7·3	6·5	2049–11
Kledang Hill, Perak ..	♂	166	191	32	21	115	43	37·6	20·6	18·1	15·5	20·8	12·1	7·6	7	4257
,, ,, ..	♂	169	193	33	21	114	44·3	38·4	20·3	18·4	16	21·4	12·3	7·7	7·2	4258
The Dindings	♀	170	173	33	22	102	40·7	35·9	19·4	17·6	14·7	19·5	11	7·2	7	1887–09
,, ...	♂	168	160	35	22	95	42·4	37·5	19·4	18·4	15·5	21·2	12·3	7·2	6·5	1889–09
,, ...	♂	171	165	33	20	96	41·8	36·3	19·1	18·1	14·6	19·9	11·6	7·2	6·5	1885–09
Below Lat. 4° N.																
Bentong, Pahang ..	♂	176	155	27	19	88	40·6	36·2	19·4	18·1	13·7	20·2	11·2	7·9	6·5	1855–10
Kuala Lumpur, Selangor ..	♂	169	161	30	22	95	40·5	36	18·4	17·5	14·5	19·5	11	7	6·7	2136–08
,, ,, ..	♀	170	180	31	..	106	42·3	37·4	20·7	18·7	15·1	20·3	11·7	7·5	7	2140–08
,, ,, ..	♀	159	178	30	20	112	41·9	35·7	..	17·5	15	20·1	11·7	7·5	6·3	1117–07
,, ,, ..	♀	164	180	32	17·5	110	42·8	37·4	19·5	18·7	14·9	20·4	11·8	7·6	6·7	2138–08
,, ,, ..	♀	165	167	30	20	101	40·7	34·8	19·3	17·3	14·7	18·7	10·7	7·2	6·5	1076–07
Klang, Selangor ..	♀	167	172	33	22	103	42	36·1	20·1	17·3	14·7	20·1	12	7·7	6·5	376–12
Nyalas, Malacca ..	♂	163	182	29	19	112	40	35·4	18·5	18	14	18·7	10·7	6·7	6·5	2546–10
,, ,, ..	♂	172	185	32	20	107	40·8	35·4	18·9	17·1	14·4	19·5	11	7·2	7·1	2545–10
,, ,, ..	♂	154	179	33	20	116	40·5	35·1	18·3	17·5	14	19·2	10·7	6·7	6·3	2547–10

R. rattus jalorensis

Rattus rattus jalorensis > *tikos*

Locality	Sex	External Measurements					Skull									Reg. No.
		Head and body	Tail	Ear	Hind-foot	Percentage of tail to head & body	Greatest length (occi-pitonasal)	Condylo-basi-lar length	Greatest zygomatic breadth	Post-molar length	Length of a nasal	Palatilar length	Length of diastema	Anterior palatal foramina	Upper molar row	
About Lat. 8° N.																
Ghirbi, Peninsular Siam ..	♂	158	176	32	17	111	40·7	35	19·4	17·1	15·2	19·3	10·6	6·9	7	77-18
,, ,, ..	♂	168	198	35	22	118	41·1	36·3	19·7	18·1	14·4	19·3	11·1	7·3	6·7	56-18
,, ,, ..	♀	160	196	34	21	122	42·6	36·7	19·2	18	16·1	19·9	11·5	7·8	6·7	67-18
,, ,, ..	♀	170	200	35	21	118	44·4	37·7	19·8	18·9	15·8	20·5	11·5	7·7	6·9	73-18
Small adults																
Temengoh, Upper Perak ..	♂	165	173	32·5	19	105	39·1	34·2	18·6	16·8	13·1	19	10·3	6·1	6·6	2054-11
Bukit Jong, Trengganu ..	♀	155	161	29	16	104	39·3	34·5	..	17·1	13·3	18·5	10·8	6·6	6·3	2343-10
Taiping, Perak	♀	155	165	33	20	106	37·7	32·6	17·8	15·6	13	17·9	10	6·7	6·5	2051-11
Semangko Pass	♀	..	..	..	..	..	38·5	34·3	18·7	17·1	12·7	18·6	10	6·4	6·7	2244-07
Segamat, Johore ..	♂	159	161	29	16	101	..	33·6	19	16·7	13·5	18·6	10·2	6·9	5·9	1087-11

4. **Rattus rattus** *form* **diardi.** The House Rat.

Mus diardii Jentink, Notes from the Leyden Museum, ii, 1879, p. 13 (west Java).

Mus griseiventer Bonhote, Fasciculi Malayenses, Zool., pt. 1, 1903, p. 30; pls. ii, fig. 3 and iv, fig. 5 (Bidor, south Perak).

External characters. A larger and more robustly built rat than *R. r. jalorensis.* The pelage less sleek and harsher; the hair on the under parts often very coarse and semi-spinous.

In the colour of the upper parts individuals of *diardi* are often very close to *jalorensis* but there are average differences that stand out in series. *Jalorensis* is, typically, very finely grizzled above with a tendency to become blackened along the spine: *diardi* is paler and more uniform with a coarse, indefinite streaking replacing the fine obvious grizzle. The under parts are never white and never sharply defined, on the flanks, against the colour of the upper parts. The colour of the under parts is very variable: the range has been well described by Kloss[1] as "buffy-white, buffy, fawn, pale grey, dark smoky grey, isabelline, rusty, drab, hair-brown, or combinations of these; frequently one colour is washed with another; sometimes there is a dark gorget and a dark median line down the abdomen." The feet are sometimes white, sometimes dark brown: often they are pale with a dark median area. Tail entirely black; half-way along its length the rings 9 to 11 to the centimetre but the larger number only in exceptionally small rats. Tail usually slightly longer than the head and body but sometimes slightly shorter: on the available series its length relative to that of the head and body very slightly greater than in *jalorensis.*

Size. In the table of measurements on page 17 the eleven largest animals available are included all with the greatest length of the skull over 43 mm. but many other adults with worn teeth are smaller than these. These latter are compared with the former in the following table. The measurements are in millimetres with some averages in brackets.—

Dimensions	Largest adults (skull over 43 mm. in greatest length)	26 smaller adults	2 exceptionally small adults
External.—			
Head and body ..	178–205 (189)	160–195 (172)	150–155 (152.5)
Tail	190–231 (206)	178–212 (187)	175 (175)
Hind-foot	34–39 (36.2)	33–39 (34.7)	32–34 (33)
Ear	20–25 (21.8)	19–23 (20.6)	19–20 (19.5)
Percentage of tail to head and body	93–119 (110)	96–119 (108)	113–117 (115)
Skull.—			
Occipito-nasal length ..	43.2–45.8 (44.4)	41.2–42.9 (42)	39.3–39.4 (39.3)
Condylo-basilar length ..	37.8–40.7	..	34.3–34.5
Greatest zygomatic breadth	19.9–22.4	..	18.4–19.5
Post-molar length ..	18.9–20.3	..	16.9–17.6
Length of a nasal ..	15.1–17	..	13.3–13.5
Palatilar length ..	20.1–22.5	..	17.1–19
Diastema	11–12.8	..	10.2–10.5
Anterior palatal foramina	7.5–8.7	..	6.7–8.4
Upper molar row ..	6.6–7.4	..	6.2–7.1

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[1] "Some Rats and Mice of the Malay Archipelago", Treubia, 11, 1921, p. 121.

Combining the above measurements we get the following ranges for adults of *R. r. diardi* in the Malay Peninsula. The minima can, I think, be regarded as exceptionally small.

Head and body	150–205 (175.7)
Tail	175–231 (190.5)
Hind-foot	32–39 (35)
Ear	19–25 (20.8)
Percentage of tail to head and body	93–119 (108.8)
Occipito-nasal length ..	39.3–45.8 (42.5)
Condylo-basilar length ..	34.3–40.7
Greatest zygomatic breadth ..	18.4–22.4
Post-molar length	16.9–20.3
Length of a nasal	13.3–17
Palatilar length	17.1–22.5
Diastema	10.2–12.8
Anterior palatal foramina ..	6.7–8.7
Upper molar row	6.2–7.4

Mammae. The number seems to be constant and the same as in *R. r. jalorensis.* All females examined have two pairs of pectoral and three pairs of inguinal mammæ making ten teats in all.

Characters of the skull. The skull is normally larger than that of *jalorensis* and more variable in detail. The palatal foramina are especially variable in shape and size: they encroach on the palate between the molars rather more frequently than in *jalorensis.* But the nine dimensions of the skulls of the animals listed in this paper, together with some additional *diardi,* adult but rather smaller than those mentioned on p. 17, examined with a slide rule, reveal no variation in the average relative proportions of the skulls of the two forms greater than about one per cent. When skulls of equal size of the two forms are compared that of *diardi* is often, although not always, the younger but there appears to be no difference of racial value.

Range in the Malay Peninsula. This rat is probably to be found in suitable situations throughout the whole length and breadth of the Malay Peninsula, but, owing no doubt to the luck of collecting, the collections examined contain no specimens from Peninsular Siam, Kedah, Kelantan, Trengganu, Pahang, Negri Sembilan and Malacca. Specimens have been examined from Pelarit, Perlis; Penang Island; Bagan Datoh, Krian Road, Taiping, Kledang Hill, and the Larut Hills in Perak, Kuala Selangor, Klang Gates, Kuala Lumpur and Rawang in Selangor; and many localities in Johore. Very common in Singapore. The small islands in the Straits of Malacca are represented only by some specimens from the coastal islet of Pulau Angsa off the coast of Selangor. This form has ascended the hills wherever there are human settlements but I have not yet seen a specimen taken above 3,000 feet.

Ecology. Essentially a house-rat but also found in cultivated areas in the immediate vicinity of permanent human settlements. It is, in fact, semi-parasitic on man. In the neighbourhood of settlements it can sometimes be trapped side by side with *R. r. jalorensis* but it seems never to be found in primary forest of any kind. In Perak specimens have been trapped in company with *R. r. argentiventer (vide infra).*

Note. Dark-bellied house-rats from the inland rural districts of the Malay States seem exactly like those occurring in Malayan ports and similar animals can also be trapped on ships coming into Singapore: all seem identical with the house-rat of Java which island is the type locality of *diardi*.

A much accepted view is that the white-bellied races of *R. rattus* are indigenous in the country in which they are found and that the dark-bellied forms are often, at least in part, derivatives now semi-parasitic on man. *R. r. diardi* may therefore be Malaysian in origin but we have no proof that this is the case and I have not yet seen an intermediate between it and *jalorensis*. We know that it is carried about by shipping and it may therefore be an immigrant but we also know that it is not identical with the dark-bellied rat of Ceylon, *Rattus rattus kandianus* var. *nemoralis* Blyth, from which it differs among other characters, in its larger feet.

Rattus rattus f. diardi

LOCALITY	Sex	EXTERNAL MEASUREMENTS					SKULL									Reg. No.
		Head and body	Tail	Hind-foot	Ear	Percentage of tail to head & body	Greatest length (occipito-nasal	Condylo-basilar length	Greatest zygomatic breadth	Post-molar length	Length of a nasal	Palatilar length	Length of diastema	Anterior palatal foramina	Upper molar row	
Largest adults:—																
Penang Island	♂	200	imp.	37	21	..	45·8	40·7	22·3	20·3	16·4	22·2	12·8	8·5	7·4	349
Mt. Kledang, Perak ..	♂	178	197	37	21	111	43·5	37·8	19·9	18·9	16	20·3	11·3	7·5	7	4260
Taiping, Perak	♂	191	204	36	25	107	44·4	38·5	20·6	19·3	15·3	21·8	12	7·5	6·9	605–13
Bagan Datoh, Perak ..	♂	180	203	37	22	113	44·6	38·7	20·9	19·5	15·4	21	12·2	8·7	6·6	581–13
" ..	♀	198	231	39	23	117	45·3	39·7	22·4	20·1	16·4	22	12·3	8·5	7·2	582–13
Kuala Selangor		185	imp.	36	25	..	44·6	40	..	19·7	17	22·5	12·8	8·7	7·1	1314–08
South Johore	♀	205	190	37	20·5	93	45·1	39·2	..	20	15·7	20·6	12·3	8·3	6·7	2539–08
"	♂	187	222	35·5	20·5	119	44·7	39·5	20·2	20·3	15·5	21·3	12·2	7·8	..	1668–08
"	♀	180	193	34·5	20	107	43·2	37·9	20·5	19·3	15·1	20·1	11	7·7	7·2	1658–08
Singapore Island ..	♀	191	imp.	34	21	..	44·3	38·8	..	19·5	15·9	21·2	12·3	8·4	7·1	4265
" ..	♀	181	206	36	21	114	43·6	38·6	20·8	19·7	15·2	20·5	11·5	7·6	7·2	4267

5. **Rattus rattus subspp.** Ship-rats.

Rats of foreign origin are brought to the ports of the Malay Peninsula by ships coming from all directions and follow subsidiary routes of commerce to remoter parts of Malaysia. Even from Christmas and Cocos Islands I have seen very dark, long-tailed rats which, if not true *R. r. rattus*[1] are very near to that form: similar examples have also been trapped on the ship trading between Singapore and Christmas Island. A few other specimens taken in warehouses at the Singapore Docks and trapped in the port on ships from Calcutta, Bangkok and elsewhere are not so blackened on the upper parts which are blackish brown: on the under parts they are slaty in colour, sometimes washed with buff. The pelage also varies in character: sometimes the fur is short and sleek, sometimes harsh and spiny. As is often the case in ship-rats it seems impossible definitely to refer such animals to either *r. rattus* or *r. alexandrinus*[2].

Less common locally are individuals in which white underparts are sharply contrasted against pale brown upper parts but such specimens are occasionally brought to Singapore on ships or are trapped on the island: they also occur in Bangkok. These rats are the ocean-going *"frugivorus"* if not identical with the wild rate of the Mediterranean countries:[3] they are not white-bellied examples of *R. r. kandianus* (Kelaart), a white bellied rat occurring in houses in Ceylon.

It is noteworthy that these ship-rats are seldom obtained even in likely localities on shore in the port of Singapore. According to Kopstein[4] a similar state of affairs obtains in the ports of Java. The rats apparently dislike leaving their restricted stations: if they land, it seems that they cannot survive, racially at least. Exceptionally long tails and dark bellies, not uncommon among the resident house-rats of Malayan ports may possibly indicate the recessive characters of immigrants.

6. **Rattus rattus** *form* **argentiventer.** The Rice-field Rat.

Epimys rattus argentiventer Robinson and Kloss, Journ. Straits Br., Royal Asiat. Soc., 73, 1916, p. 274 (Pasir Ganting, west coast of Sumatra).

Rattus rattus argentiventer, Rob. and Kloss, Journ. F.M.S. Mus., viii, pt. 2, 1918, p. 55.

Rattus argentiventer, Chasen and Kloss, Journ. Malay. Br., Royal Asiat. Soc., vi, 1929, p. 47.

External characters. Like *R. r. diardi* this is a larger form than *jalorensis.* As could be expected of a field-rat it has the smooth pelage of *jalorensis* rather than the coarse pelage of *diardi* and unlike the latter the under parts, as in *jalorensis,* seem never to be semi-spinous.

In colour *argentiventer* is distinctive, differing from both *jalorensis* and *diardi* above and below. The upper parts are coarsely and boldly grizzled with a tendency to blackening along the middle line. The under parts, in the great majority of specimens, are of a peculiar, very pale grey: they could be described alternatively as white, overlaid with silver, and quite unlike the heavy drab and grey under side of *diardi* and the dead white, or, more rarely, white sullied with dull grey, of *jalorensis.* In a few specimens, the underparts are white. More often than not there are in *argentiventer* faint indications of a darker gorget and middle line.

Feet always mostly dark.

Tail black throughout: half-way along its length the rings 9 to 11 to the centimetre. Relative length of the tail as in *jalorensis* and on series a trifle shorter than in *diardi.*

This rat is perhaps less stable in colour than either *jalorensis* or *diardi*: the relatively small number examined has already produced a pure albino; a variety creamy-fawn above and white below; and a third specimen tending to melanism on the upper parts.

Size. The measurements in millimetres of nineteen good adults with worn teeth from a limited locality in Perak are given in detail on page 24 and summarized below: some averages are given in brackets.

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[1] According to Wood-Jones ("Coral and Atolls") on one of the islands of the Cocos-Keeling group the whole colony of rats consists of black rats which also turn up, as stragglers, on some of the other islands.

[2] I have been fortunate in obtaining the co-operation of Dr. A. W. J. D'Cruz, the Port Health Officer of Singapore and have examined many rats caught on ships and in the Port.

[3] This is not the place to discuss the systematic status of the immigrant *rattus* rats which has been conveniently summarized by Hinton in Journ. Bomb. Nat. Hist. Soc., xxvi, 1918, pp. 63-68 and British Museum (Natural History), Economic Series, No. 8, pp. 2-5. This author notices that the three colour phases may exist in one colony, that they may occasionally occur in the same litter in colonies of mixed origin and yet each has a certain geographical value and each will breed true to type under favourable conditions. All three have been carried by human agency to various ports of the world: a large percentage of ship-rats is composed of the races *frugivorus* and *alexandrinus.*

[4] *See* 4 above.

Head and body	160–194 (178)
Tail	165–210 (185)
Hind-foot	34–41 (36.5)
Ear	20.–24.5 (22.5)
Percentage of tail to head and body	97–113 (104)
Occipito-nasal length	40.4–45.8 (42.2)
Condylo-basilar length	35.3–39-7
Greatest zygomatic breadth	19.4–21.8
Post-molar length	17.2–19.8
Length of a nasal	14.2–17.5
Palatilar length	19.2–22.1
Diastema	10.6–12
Anterior palatal foramina	6.7–8.5
Upper molar row	7.1–7.9

Mammae. R. r. argentiventer differs from *jalorensis* and *diardi* in the possession of three pairs of pectoral mammæ making twelve teats in all.

Characters of the skull. The skull differs from that of *jalorensis* in its larger size but in its major proportions it is almost identical except that the tooth-row is slightly longer averaging about 20% of the condylo-basilar length instead of about 18% shewn by long series of *jalorensis*. It also differs in that in all the specimens examined a line drawn across the anterior roots of M^1 invariably includes the tips of the anterior palatal foramina for a length of up to 1.5 mm. Other marked actual differences not correlated with the difference in size between the skulls of the two forms are that in *argentiventer* the infra-orbital plate is broader; the teeth, including the incisors, are larger; and the bullæ are much larger, more dilated. The skull is more like that of *diardi* because of the closer approximation in size but the points of distinction mentioned above with regard to *jalorensis* apply equally well to *diardi* with the exception of that concerning the relation of the palatal foramina to the intermolar space, which as already noted above is a very variable character in *diardi*.

Range in the Malay Peninsula. The great majority of the specimens examined is from the rice-fields of Krian, northwest Perak (Bagan Tiang, Parit Buntar, Briah, Tanjong Piandang, Kuala Kurau, Bagan Serai, Gunong Semanggol, and Selensing. There are also specimens from Krian Road near Taiping; from Rubana Estate near Telok Anson[1]; and from Rungkup Estate, Bagan Datoh in Lower Perak. To the north I have traced this form to Kedah Peak; Bangnara on the coast of Patani, Peninsular Siam; and to Bangkok. South of Perak I know it only from Cheras, near Kuala Lumpur in Selangor.

Ecology. The Rat Destruction Officer, Krian, Perak, has kindly forwarded some interesting notes on the habits of this rat. It lives in the open rice-fields feeding freely on the growing rice crops, grasses, roots and insects, especially grasshoppers. The breeding season is, generally speaking, from the beginning of harvest until late July or August, but it depends largely on the supply of food available. The early nests are in the dry grass ridges round the open fields but when the country becomes flooded the rats nest in and around the nipah palms away from villages and along the earth bunds. The average litter in 1932 was ten. Unlike *diardi* the rice-field rat does not infest villages.

Note. The rice-field rat of the Malay Peninsula is here referred to *R. r. argentiventer* Rob. and Kloss, but the identification needs confirmation as *argentiventer* is only definitely known from the west Sumatran type and unique specimen not now available for examination. The published measurements of the type together with those of a single specimen from eastern Borneo referred to the same form, again without direct reference to the type, are given at the bottom of the table on p. 23.

It will be noticed that the type, said to be an adult with worn teeth, has a smaller hind-foot and a tail relatively a trifle shorter than any of the Malayan specimens. The Bornean specimen is even shorter in the tail than the type but this may be due to the method of measuring in the flesh: otherwise, as far as a badly smashed skull will allow comparison, it only differs from some Malayan examples in its darker underparts.

In Java the rice-field rat *R. rattus brevicaudatus* Horst and De Raadt, and the field-rat, *R. r. roquei* present almost the same points of distinction as do *argentiventer* and *jalorensis* in the Malay Peninsula although between these last mentioned forms there is no difference in the relative length of tail. Normally, *R. r. roquei* has white under parts, two pairs of pectoral mammæ, and the comparative characters of a long tail and small bullæ: *brevicaudatus* has the under parts washed with silvery grey and three pairs of pectoral mammæ; the tail is comparatively short and the bullæ large.

Until a series of topotypical *argentiventer* is available for comparison it is impossible to proceed further with the systematics of these rats beyond remarking that Malayan *argentiventer* and typical *brevicaudatus* of Java seem very close. On published figures the latter has a relatively slightly shorter tail

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[1] *See* L. Wray, "Notes on the Sugar Cane Rat", (referred to *jalorensis*) in Journ. F.M.S. Mus., 2, 1905, p. 39.

(80–105% of the head and body) but I have never seen a really good series of adults from Java. One of these forms is no doubt the same as true *argentiventer* (1916) of Sumatra, which name has priority over *brevicaudatus* (1918). By analogy, Sumatran and Malayan animals are most likely to belong to the same race and are here so regarded, but the Bornean race could be either *argentiventer* or *brevicaudatus*.

I can see no justification for applying a simple trinominal nomenclature to this group of rats. Most zoologists now define a subspecies as a geographical race although many, especially some ornithologists, take a very broad view about these races and regard as subspecies certain forms now overlapping in range, and in extreme cases perhaps even breeding in the same area: in any case it is always contended that the differences were, and still are, mainly geographic in value. On this view the three forms of *R. rattus* indigenous in Europe can fairly be regarded as subspecies but in the Malay Peninsula the case is not parallel. Three distinct rats occupy three different types of country, sometimes in close proximity: the differences in their ranges are only geographical in the remotest sense and purely ecological and there seems no reason to make an exception to the custom of nomenclature in their favour. The system of naming here adopted is therefore a departure from precedent in this particular case.

The view that both *diardi* and *argentiventer* are derivatives of *jalorensis* and now semi-parasitic on man may be correct for it is significant that neither is found in virgin country: but *diardi* might also well be of foreign origin. Since the recognition of *argentiventer* all the *rattus* rats seen from the Peninsula are definitely referable to one of the three forms and although the differences between these forms are as well marked as those separating many "species" they cannot be regarded as such because of the peculiarly restricted nature of their habitat.

Rattus rattus f. argentiventer

Locality	Sex	External Measurements					Skull									Reg. No.
		Head and body	Tail	Hind-foot	Ear	Percentage of tail to head & body	Greatest length (occipitonasal)	Condylo-basilar length	Greatest zygomatic breadth	Post-molar length	Length of a nasal	Palatilar length	Length of diastema	Anterior palatal foramina	Upper molar row	
Perak	♂	192	197	37	20	103	42·2	37·6	21·1	18·4	14·4	20·6	11·8	7·7	7·2	4250
"	♂	186	191	36	21	103	43·3	37·5	21·3	17·9	15·4	20·5	12	7·6	7·3	4249
"	♀	185	180	36	20	97	42	37·3	20·5	18·4	14·9	20·2	11·3	7·7	7.4	4262
"	♀	170	166	34	22	98	42·9	37·7	21·4	18·7	14·7	20·3	11·3	7·5	7·5	4254
"	♂	185	210	39	21	113	45·8	39·7	21·8	19·8	17·5	22·1	11·9	8·3	7·7	125
"	♂	180	185	36	22	103	42·2	37·1	19·7	18·3	14·4	20·2	11	7·2	7·5	274–32
"	♂	194	200	41	24	103	44·6	39·1	20·8	19·3	15·1	20·9	12	8·5	7·6	249–32
"	♂	180	200	38	23	111	..	38	19·9	18·1	..	20·6	12	8	7·7	273–32
"	♂	178	185	38	23	104	40·7	..	20·3	..	14·4	20	11·3	7·9	7·4	278–32
"	♂	178	194	36	23	109	41·8	37	20·7	18·2	15	20·2	11·3	7·3	7·1	242–32
"	♂	192	190	40	24·5	99	42·9	38	20·3	18·3	14·9	21·2	11·7	8·2	7·5	232–32
"	♂	178	190	37	24	107	41·9	35·3	19·5	17·2	14·8	19·3	10·6	7·7	7·1	234–32
"	♀	160	165	35	23	103	40·4	36·8	19	17·9	14·2	20	11·7	6·7	7·2	214–32
"	♀	172	175	36	23	102	41·8	36·7	20·7	17·3	14·6	20·5	11·4	7·7	7·7	272–32
"	♀	180	188	36	25	104	..	36·7	20·5	17·7	..	20·1	10·9	7·6	7·6	257–32
"	♀	170	180	34	22	106	43	38	21	18·4	14·8	21	11·8	8·1	7·1	223–32
"	♀	165	170	35	22	103	40·6	35·9	19·4	17·5	14·5	19·2	10·7	7·1	7·3	290–32
"	♀	165	175	35	23	106	41·1	36·7	20	17·8	14·3	20	11·3	8·1	7·2	276–32
"	♀	165	180	36	22	109	41·4	36·6	20·1	17·7	14·9	20·3	11	7·9	7·9	294–32
Korinchi, W. Sumatra ..	♂	184	173	32	20	94	41	36·2	19·8	..	14·7	..	11	8·5	7·9	602–14
East Borneo	♀	174	159	34	..	90	..	..	18·7	..	13·8	18·1	10	7·7	7·2	..

Summary (Adults)

CHARACTER	R. JALORENSIS	R. ARGENTIVENTER	R. DIARDI
General	A lightly built rat with sleek pelage	More heavily built with sleek pelage	Like *argentiventer* but pelage harsher: on the under parts often coarse and semi-spinous
Colour of upper parts ..	Finely grizzled	Coarsely and boldly grizzled	Paler and more uniform with a coarse, indefinite streaking
Colour of under parts	White, sharply defined on the flanks: sometimes clouded with dull grey	White, overlaid with silver: sharply defined on the flanks	Never white but grey to brown: not defined but merging with the dark upper parts on the flanks
Head and body in mms ..	154–176 (165·6)	160–194 (178)	150–205 (175.7)
Tail	155–193 (173)	165–210 (185)	175–231 (190.5)
Percentage of tail to head and body	88–115 (104.5)	97–113 (104)	93–119 (108.8)
Hind-foot s.u.	27–35 (31.4)	34–41 (36.5)	32–39 (35)
Ear	16–22 (19.8)	20–24.5 (22.5)	19–25 (20-8)
Greatest length of skull ..	37.7–44.3 (40.9)	40.4–45.8 (42.2)	39.3–45.8 (42.5)
Characters of skull ..	In the great majority of skulls a line drawn across the anterior roots of M^1 excludes the palatal foramina	Larger. Toothrow relatively slightly longer Line across M^1 invariably includes tips of palatal foramina Infra-orbital plate broader Teeth larger Bullae larger, more dilated	Skull as in *jalorensis* but larger and more variable in detail. Palatal foramina especially variable
Mammae	2 : 3	3 : 3	2 : 3
Habitat	Forest of all kinds	Rice-fields	Associated with man. In houses, villages, etc.